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TABLES OF SCALES OF MAPS

AND

STADIA REDUCTION TABLES.

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18F

SCALES OF MAPS.

50. Before proceeding to make a reconnaissance, even with the equipment just described and a knowledge of its use, the topographer must decide a few questions, ignorance of which may cost him his position, or cause him to fail entirely when success was almost within his grasp. Amongst them there may be mentioned:

1. The selection of the scales of his sketches, and their relation to the final drawings.

2. The use of some systematic method of taking and recording notes, which may be intelligible to one not familiar with the ground.

3. The exercise of considerable discretion as to what features should be introduced and what omitted without waste of time.

4. The marking of reference-points in the field so as to be readily found by others.

5. The method intended to be used in working up the data or the *form of computations*, whether graphical or analytical. It will only be necessary here to touch upon the first two of the above points before beginning with the field work, when the remaining ones will follow in proper sequence.

They should be well considered, however, before work is begun, as some of them will recur at every change of station and must be answered; but as they are all more or less contingent upon the scale of the map, the topographer should first select that with a view to show clearly all necessary details and no more, remembering that anything superfluous is a wasteful expenditure of time and money. The degree of accuracy to be observed in conducting the survey is also a function of the scale, as it is useless to attempt to avoid errors which are too small to appear on the map. See § 162 on Limits of Error.

51. *The Scale* may be defined to be the ratio of the field or

object to the plot or drawing—and may be expressed in the form of a fraction, obtained by dividing the second quantity by the first. Thus if F represent the field and P the plot, the ratio or scale would be $\frac{P}{F}$. The antecedent, the real tangible object to be represented, being the unit of comparison is made the divisor or first quantity, whilst the variable representation of that object, which may be made of any size sufficiently large to show the parts, is taken as the second quantity or consequent; as in a geometrical progression, where the ratio is the quotient of any consequent divided by its antecedent.

52. Thus if *n* represent the number of units of the Field corresponding to one unit of the Plot, the general formula becomes an equality of ratios, $\frac{P}{F} = \frac{1}{n}$ from which it follows that $F = Pn$ or $P = \frac{F}{n}$; in other words, *any length in the field is obtained by multiplying its homologous line of the plot by the denominator of the scale*, and *any line on the plot is obtained by dividing the corresponding field dimension by the denominator of the scale.*

The units must invariably be of the same denomination. By observing these suggestions no confusion can arise as to what is meant by the scale. Thus, 1 mile to the inch=63360 inches to 1 inch, or $\frac{1}{63360}$. Three miles to an inch would be $\frac{1}{190080}$—and of these two scales thus expressed there is no doubt as to which is the larger, since the first divided by the second gives a quotient of 3. In general if a scale (A) be represented by $\frac{1}{N}$ and another (B) by $\frac{1}{S}$ the ratio of A to B will be $\frac{B}{A} = \frac{1}{S} \div \frac{1}{N} = \frac{N}{S}$, which may be a whole number or fraction. If N=2s, then $\frac{B}{A} = 2$, or B is twice as large as A.

Again if we wish to make a new scale B any number of times a given scale A, as $p\,A$, we substitute this value for B in the above equation and obtain $s = \frac{N}{p}$, or in other words divide the denominator of the fraction expressing the given scale by the multiplier (whether whole or fractional) for the denominator of the new scale. Thus if N = 63360 and p be $\frac{1}{3}$, s will be 190080, and the scale B will $= \frac{1}{190080}$.

It should be remembered also that a *larger scale always means*

a magnified representation of the surface as compared with some other map, and not a greater number of linear units to the inch or a greater area of surface represented in a given square of the map. For instance, 6 miles to an inch is not greater but less than one mile to the inch, being but ⅙ the size—that is, it would take a much smaller sheet of paper to represent a given area at 6 miles than at 1 mile to the inch.

53. The scales of maps expressed decimally are to be avoided as unintelligible, as e. g., the number .00020⅚, a mixed vulgar and decimal fraction, means simply a scale of $\frac{1}{4800}$, or 4800 feet to 1 foot = 400 feet to 1 inch.

54. It is always desirable to use the largest scale for the field notes, and sub-multiples of these for the compiled sheets. So far as possible, the same scale should be used for all the parts of an extended survey, that the several sections may be united in a general map. Exceptions may be made in case of special features requiring more minute study.

55. In some foreign countries, as Prussia, Austria and Switzerland, the plane table sheets for topography are plotted on a scale of $\frac{1}{25000}$; in Italy, on a scale of $\frac{1}{50000}$, and in Sweden, $\frac{1}{100000}$. The older British charts and maps of kingdoms were made on a scale of 1 mile to 1 inch, or $\frac{1}{63360}$; the later maps of counties are 1 mile to 6 inches, or $\frac{1}{10560}$; but these latter, while not being large enough to show parish boundaries with sufficient accuracy, require about six times the amount of labor in their preparation, and are inconvenient, so that at present, populous, cultivated and mineral districts in Great Britain are plotted on a scale of $\frac{1}{2500} = 1^m$ to 25.344″, in which an English acre is represented by one square inch, while the thinly settled districts retain the scale of 1^m to 6″ $= \frac{1}{10560}$. For plans of cities of over 4,000 inhabitants, a scale of $\frac{1}{500}$, or 1^m to 10.56 feet is used, and for towns and villages $\frac{1}{1056}$, or 1^m to 5 feet, is general. Of their relative cost, the parish surveys are estimated at 25 cents per acre; the county, at 21½ cents for cultivated, and 12½ for uncultivated districts; and for kingdoms at $40 per square mile.

The scale used by Prussia and Switzerland for general maps is $\frac{1}{100000}$, or ¼ that of the detail sheets of the plane table surveys.

In France the topographical maps are made on scales of

1 : 10,000, 1 : 20,000, 1 : 40,000, and 1 : 80,000. The maps of the *Corps des Ponts et Chaussée* are on a scale of 1 : 5000 and of 1 : 500. The scales most in use for very exact details are 1 : 2,500 to 1 : 5,000.

56. On the Second Geological Survey of Pennsylvania, a system of scales ranging from 400 to 1600 feet to one inch is employed ($\frac{1}{4800}$ to $\frac{1}{19200}$)—the largest scale, 400 feet to 1″, being used in the note book, which is divided into quarter inch or 100 foot squares. Ten feet would then be represented by $\frac{1}{40}$ of an inch, sufficient to show a small building.

The district maps of the city of Philadelphia are made on a scale of 200 feet to 1 inch, or $\frac{1}{2400}$.

57. Cadastral maps of farms, parks, etc., may be conveniently plotted to a scale of 50 or 100 feet to an inch = $\frac{1}{600}$ or $\frac{1}{1200}$; but frequently, especially in old surveys, a certain number of poles or chains may be taken per unit.

58. To assist in determining rapidly the equivalent numbers of such variable standards of comparison as may be represented by a linear unit of the map, or the reciprocal extent of map covered by a unit of the standard, two tables have been prepared which will be found appended.—To these have been added the number of acres to the square inch of map for the various scales given in the list. These will prove valuable in rapidly estimating contents—by counting the number of square inches on the map, or by the use of the planimeter.

Should a scale be sought which is not included in the table, its multiple or sub-multiple may be found, and the quantities taken from the table multiplied by this factor will give the required amount, excepting in the area column.

To find the number of acres in the square inch, square the number of chains as given in that column and divide by one hundred.

Table of Map Equivalents giving for each

No.	Scale.	Miles.	Kilometers.	Chains.	Poles.
1.	1/7 349 760	116.	186.6821	9280.000	37120.00
2.	1/2 090 880	33.	53.1078	2640.000	10560.00
3.	1/1 267 200	20.	32.18663	1600.000	6400.00
4.	1/1 200 000	18.9393	30.4791	1515.151	6060.60
5.	1/1 013 760	16.	25.7492	1280.000	5120.00
6.	1/1 000 000	15.7828	25.3992	1262.624	5046.50
7.	1/823 680	13.	20.9209	1040.00	4160.00
8.	1/811 008	12.8000	20.5994	1024.000	4096.00
9.	1/760 320	12.	19.3129	960.000	3840.00
10.	1/696 960	11.	17.7023	880.00	3520.00
11.	1/635 000	10.0221	16.1286	801.768	3207.07
12.	1/633 600	10.	16.09320	800.000	3200.00
13.	1/600 000	9.4696	15.2398	757.575	3030.30
14.	1/506 880	8.	12.87456	640.000	2560.00
15.	1/500 000	7.8914	12.6996	631.313	2525.25
16.	1/443 520	7.	11.2651	560.00	2240.00
17.	1/400 000	6.3131	10.1597	505.050	2020.20
18.	1/380 160	6.	9.65587	480.000	1920.00
19.	1/375 000	5.9185	9.5239	473.480	1893.92
20.	1/316 800	5.	8.04664	400.000	1600.00
21.	1/300 000	4.7348	7.61992	378.780	1515.15
22.	1/253 440	4.	6.43732	320.00	1280.00
23.	1/240 000	3.7878	6.09570	303.030	1212.12
24.	1/200 000	3.15656	5.07985	252.525	1010.10
25.	1/190 080	3.	4.82793	240.000	960.00
26.	1/160 000	2.5252	4.0638	202.020	808.08
27.	1/150 000	2.36742	3.80496	189.393	757.57
28.	1/126 720	2.	3.21866	160.000	640.0
29.	1/120 000	1.89393	3.05784	151.515	606.06
30.	1/100 000	1.57828	2.53995	126.262	505.05
31.	1/80 000	1.2626	2.0319	101.010	404.04
32.	1/79 200	1.2500	2.01166	100.000	400.00
33.	1/76 800	1.21212	1.9604	96.967	387.87
34.	1/63 360	1.	1.6093	80.000	320.00
35.	1/60 000	0.94696	1.52392	75.757	303.03
36.	1/59 400	0.9375	1.50874	75.000	300.0
37.	1/50 000	0.78914	1.26996	63.131	252.52
38.	1/47 520	0.7500	1.20696	60.00	240.00
39.	1/40 000	0.63131	1.0159	50.500	202.02
40.	1/39 600	0.6250	1.0058	50.000	200.0
41.	1/39 370	0.62138	1.	49.710	198.88
42.	1/38 400	0.6060	0.9752	48.484	193.93
43.	1/38 016	0.6000	0.9656	47.925	191.70
44.	1/31 680	0.5000	0.80465	40.00	160.00
45.	1/30 000	0.47348	0.7619	37.878	151.48
46.	1/25 344	0.4	0.64373	32.000	128.00
47.	1/25 000	0.39457	0.63967	31.565	126.26
48.	1/23 760	0.37500	0.60349	30.000	120.00
49.	1/21 120	0.33333	0.53589	26.666	106.66

lineal inch of Map, the following number of

Meters.	Yards and Feet { of Actual Distance.		No. of Acres to the sq. inch.	Where Used.	No.
186682.18	204160.0	612480.0	. . . . .	Map of U. S. . .	1.
53107.86	58080.0	174240.0	. . . . .	Map of Pa. . . .	2.
32186.635	35200.0	105600.0	. . . . .	U. S. C. S. . .	3.
30479.7	33333.3	100000.0	229567.	U. S. C. S. . . .	4.
25749.27	28160.0	84480.0	163840.	△ India	5.
25399.2	27755.7	83333.3	159420.	U. S. C. S. . . .	6.
20920.9	22880.0	70640.	114555.	. . . . .	7.
20599.416	22528.0	67584.0	104845.	. . . . .	8.
19312.95	21120.0	63360.0	92160.	R. R. Va. . . .	9.
17702.3	19360.0	57080.0	74796.	. . . . .	10.
16128.6	17638.9	52916.6	64283.	U. S. C. S. . . .	11.
16093.29	17600.0	52800.0	64000.	U. S. Eng. . . .	12.
15239.8	16666.6	50000.0	57392.	U. S. C. S. . . .	13.
12874.65	14080.0	42240.0	40960.	Eng. Ord. Sur. .	14.
12699.6	13888.8	41666.6	39855.	U. S. C. S. . . .	15.
11265.1	12320.0	36960.	31360.	. . . . .	16.
10159.7	11111.1	33333.3	25507.	U. S. C. S. . . .	17.
9655.87	10560.0	31680.0	23040.	Ludlow's Rep. .	18.
9523.9	10416.5	31250.0	22419.	U. S. C. S. . . .	19.
8046.64	8800.0	26400.0	16000.	Barnes' Pa. . . .	20.
7619.9	8344.3	25000.0	14348.	U. S. C. S. . . .	21.
6437.333	7040.	21120.	10240.	. . . . .	22.
6095 7	6666.6	20000.0	9183.	U. S. C. S. . . .	23.
5079.8	5555.5	16666.6	6372.	U. S. C. S. . . .	24.
4827.93	5280.0	15840.0	5760.	Ludlow's Rep. .	25.
4063.8	4444.4	13333.3	4448.5	U. S. C. S. . . .	26.
3804.9	4166.6	12500.0	3587.	U. S. C. S. . . .	27.
3218.66	3520.0	10560.0	2560.	Sherman's March.	28.
3057.8	3333.3	10000.0	2296.	U. S. C. S. . . .	29.
2539.9	2777.7	8333.3	1594.	U. S. C. S. . . .	30.
2031.9	2222.2	6666.6	1112.	U. S. C. S. . . .	31.
2011.7	2200.0	6600.0	1000.	. . . . .	32.
1960.5	2133.3	6400.0	940.	Geol. Sur. . . .	33.
1609.3	1760.0	5280.0	640.0	Fremont	34.
1523.9	1666.6	5000 0	573.7	U. S. C. S. . . .	35.
1508.73	1650.0	4950.0	562.5	. . . . .	36.
1269.9	1388.8	4166.6	398.53	U. S. C. S. . . .	37.
1206.975	1320.	3960.	360.	. . . . .	38.
1015.9	1111.1	3333.3	255.05	U. S. C. S. . . .	39.
1005.83	1100.0	3300.0	250.00	U. S. C. S. . . .	40.
1000.0	1093.6	3280.8	247.00	. . . . .	41.
975.24	1066.6	3200.0	235.08	Geol. Surv. Pa. .	42.
965.59	1054.3	3163.0	229.67	. . . . .	43.
804.650	880.	2640.	160.0	. . . . .	44.
761.9	833.3	2500.	143.48	U. S. C. S. . . .	45.
643.728	704.0	2112.0	102.2	. . . . .	46.
639.673	694.4	2083.3	99.64	. . . . .	47.
603.487	660.0	1980.0	90.00	. . . . .	48.
535.897	586.6	1760.0	70.859	. . . . .	49.

Table of Map Equivalents giving for each

No.	Scale.	Miles.	Kilometers.	Chains.	Poles.
50.	1/20 000	0.31565	0.50798	25.2525	101.01
51.	1/19 880	0.31250	0.50290	25.000	100.
52.	1/19 200	0.30303	0.48762	24.242	96.96
53.	1/18 818	0.29700	0.47796	23.760	95.04
54.	1/15 840	0.25000	0.40232	20.	80.
55.	1/15 000	0.23674	0.38099	18.9393	75.75
56.	1/11 800	0.18750	0.30174	15.	60.
57.	1/10 000	0.1578	0.25417	12.626	50.505
58.	1/9 900	0.15625	0.25100	12.500	50.
59.	1/9 600	0.15151	0.24376	12.121	48.484
60.	1/7 920	0.12500	0.20112	10.	40.
61.	1/7 200	0.1136	0.18378	9.0909	36.363
62.	1/6 000	0.09471	0.15285	7.5757	30.303
63.	1/5 940	0.09375	0.15092	7.5000	30.
64.	1/5 000	0.078913	0.12695	6.31313	25.252
65.	1/4 950	0.078123	0.12582	6.250	25.
66.	1/4 800	0.07575	0.121881	6.0606	24.242
67.	1/3 960	0.06250	0.100561	5.	20.
68.	1/3 600	0.05681	0.091391	4.5303	18.121
69.	1/3 333	0.05261	0.08463	4.2060	16.824
70.	1/3 168	0.05	0.080466	4.	16.
71.	1/3 000	0.04734	0.07610	3.7787	15.151
72.	1/2 970	0.04687	0.07541	3.75	15.
73.	1/2 500	0.03945	0.06396	3.1565	12.626
74.	1/2 400	0.03787	0.06098	3.0379	12.1515
75.	1/1 980	0.03125	0.05029	2.5	10.
76.	1/1 280	0.02020	0.032507	1.6016	6.406
77.	1/1 250	0.019728	0.031697	1.5767	6.307
78.	1/1 200	0.018939	0 030578	1.5151	6.060
79.	1/1 080	0.017046	0.027520	1.3636	5.454
80.	1/1 000	0.0157	0.0254	1.2626	5.0505
81.	1/960	0.01515	0.024376	1.2121	4.848
82.	1/840	0.013258	0.021399	1.06057	4.2420
83.	1/792	0.0125	0.02011	1.	4.
84.	1/720	0.01136	0.018378	0.9091	3.6363
85.	1/600	0.009471	0.015285	0.75757	3.0303
86.	1/500	0.0078913	0.012695	0.63131	2.5252
87.	1/480	0.007575	0.012188	0.60606	2.4242
88.	1/360	0.00568	0.009139	0.45303	1.8121
89.	1/300	0.004734	0.007610	0.37787	1.5151
90.	1/240	0.003787	0.006098	0.30379	1.2151
91.	1/198	0.003125	0.005029	0.25	1.
92.	1/120	0.001894	0.003057	0.15151	0.6060
93.	1/69	0.000947	0.001528	0.07575	0.3030
94.	1/39.37043	0.0006213	0.001	0.0497101	0.1988405
95.	1/36	0.000568	0.0009139	0.045303	0.181212
96.	1/12	0.0001894	0.0003057	0.015151	0.0606
97.	1/1	0.00001578	0.00002536	0.0012595	0.00505

lineal inch of Map, the following number of

Meters.	Yards and Feet { of Actual Distance.		No. of Acres to the sq. inch.	Where Used.	No.
507.98	555.5	1666.6	63.72	. . . . .	50.
502.906	550.0	1650.0	62.50	U. S. C. S. . . .	51.
487.617	533.3	1600.0	58.767	. . . . .	52.
477.96	522.72	1568.1	56.45	U. S. C. S. . . .	53.
402.325	440.	1320.	40.00	. . . . .	54.
380.99	416.66	1250.	35.87	U. S. C. S. . . .	55.
301.744	330.	990.	22.475	. . . . .	56.
254.177	277.77	833.33	15.942	U. S. C. S. . . .	57.
251.004	275.	825.	15.625	. . . . .	58.
243.533	266.66	800.	14.070	2d Geol. Surv. Pa.	59.
201.125	220.	660.	10.	. . . . .	60.
183.782	200.	600.	8.264+	. . . . .	61.
152.854	166.66	500.	5.739+	. . . . .	62.
150.924	165.	495.	5.625+	. . . . .	63.
126.950	138.888	416.66	3.985+	U. S. C. S. . . .	64.
125.8238	134.166	412.50	3.906	. . . . .	65.
121.88175	133.333	400.	3.672	2d Geol. Surv. Pa.	66.
100.5625	110.	330.	2.5	. . . . .	67.
91.391	100.	300.	2.066+	. . . . .	68.
84.6334	92.592	277.7	1.7713+	U. S. C. S. . . .	69.
80.0466	88.	264.	1.6	. . . . .	70.
76.1057	83.333	250.	1.434+	. . . . .	71.
75.4138	82.5	247.5	1.406+	. . . . .	72.
63.9673	69.444	208.33	.9963+	U. S. C. S. . . .	73.
60.9811	66.666	200.	.9182+	U. S. C. S. . . .	74.
50.2906	55.55	166.66	.6376+	. . . . .	75.
32.5079	35.555	106.66	.2611+	U. S. C. S. . . .	76.
31.6973	34.7222	104.166	.2491+	U. S. C. S. . . .	77.
30.578	33.3333	100.	.229+	U. S. C. S. . . .	78.
27.520	30.	90.	.185+	. . . . .	79.
25.4177	27.777	83.333	.1594	. . . . .	80.
24.3763	26.666	80.	.146+	. . . . .	81.
21.4046	23.3333	70.	.112+	. . . . .	82.
20.1125	22.	66.	.100+	. . . . .	83.
18.3782	20.	60.	.0826+	. . . . .	84.
15.2854	16.666	50.	.0573+	. . . . .	85.
12.695	13.8888	41.666	.0398+	U. S. C. S. . . .	86.
12.18817	13.3333	40.	.0367+	. . . . .	87.
9.1391	10.	30.	.0206+	. . . . .	88.
7.61975	8.3333	25.	.0143+	. . . . .	89.
6.09811	6.6666	20.	.0092+	. . . . .	90.
5.02906	5.555	16.666	.00637+	. . . . .	91.
3.0578	3.3333	10.	.00229+	U. S. C. S. . . .	92.
1.52854	1.6666	5.	.00057+	. . . . .	93.
1.	1.0936	3.28087	.000247+	. . . . .	94.
0.91391	1.	3.	.000206+	. . . . .	95.
0.3047972	0.3333	1.	.0000229+	. . . . .	96.
0.025368	0.02777	0.083	.00000158+	. . . . .	97.

M.	0°		1°		2°		3°		4°		5°		6°		7°		8°		9°		10°		M.
	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	
0′, . .	100.00	.00	99.97	1.74	99.88	3.49	99.73	5.23	99.51	6.96	99.24	8.68	98.91	10.40	98.51	12.10	98.06	13.78	97.55	15.45	96.98	17.10	. . 0′
2. . .	"	.06	"	1.80	99.87	3.55	99.72	5.28	"	7 02	99.23	8.74	98.90	10.45	98.50	12.15	98.05	13.84	97.53	15.51	96.96	17.16	. . 2
4, . . .	"	.12	"	1.86	"	3.60	99.71	5 34	99.50	7.07	99.22	8.80	98.88	10.51	98.48	12.21	98.03	13.89	97.52	15 56	96.94	17.21	. . 4
6, . .	"	.17	99.96	1.92	"	3.66	"	5.40	99.49	7.13	99.21	8.85	98.87	10.57	98.47	12.26	98.01	13.95	97.50	15.62	96.92	17.26	. . 6
8, . . .	"	.23	"	1.98	99.86	3.72	99.70	5.46	99.48	7.19	99.20	8.91	98.86	10.62	98.46	12.32	98.00	14.01	97.48	15.67	96.90	17.32	. . 8
10, . .	"	.29	"	2.04	"	3.78	99.69	5.52	99.47	7.25	99.19	8.97	98.85	10.68	98.44	12.38	97.98	14.06	97.46	15.73	96.88	17.37	. . 10
12, . .	"	.35	"	2.09	99.85	3.84	"	5.57	99.46	7.30	99.18	9.03	98.83	10.74	98.43	12.43	97.97	14.12	97.44	15.78	96.86	17.43	. . 12
14, . . .	"	.41	99.95	2.15	"	3.90	99.68	5.63	"	7.36	99.17	9.08	98.82	10 79	98.41	12.49	97.95	14.17	97.43	15.84	96.84	17.48	. . 14
16, . . .	"	.47	"	2.21	99.84	3.95	"	5.69	99.45	7.42	99.16	9.14	98.81	10.85	98.40	12.55	97.93	14.23	97.41	15.89	96.82	17.54	. . 16
18, . . .	"	.52	"	2.27	"	4.01	99.67	5.75	99.44	7.48	99.15	9.20	98.80	10.91	98.39	12.60	97.92	14.28	97.39	15.95	96.80	17.59	. . 18
20, . . .	"	.58	"	2.33	99.83	4.07	99.66	5.80	99.43	7.53	99.14	9.25	98.78	10.96	98.37	12.66	97.90	14.34	97.37	16.00	96.78	17.65	. . 20
22, . .	"	.64	99.94	2 38	"	4.13	"	5 86	99.42	7.59	99.13	9.31	98.77	11.02	98.36	12.72	97.88	14.40	97.35	16.06	96.76	17.70	. 22
24, . .	"	.70	"	2 44	99.82	4.18	99.65	5.92	99 41	7.65	99.11	9.37	98.76	11.08	98.34	12.77	97.87	14.45	97.33	16.11	96.74	17.76	. . 24
26, . .	99.99	.76	"	2.50	"	4.24	99.64	5.98	99.40	7.71	99.10	9.43	98.74	11.13	98.33	12.83	97.85	14.51	97.31	16.17	96.72	17.81	. . 26
28, . .	"	.81	99.93	2 56	99.81	4.30	99.63	6.04	99.39	7.76	99.09	9.48	98.73	11.19	98.31	12.88	97.83	14.56	97.29	16.22	96.70	17.86	. . 28
30, . .	"	.87	"	2.62	"	4.36	"	6.09	99.38	7.82	99.08	9.54	98.72	11.25	98.29	12.94	97.82	14.62	97.28	16.28	96.68	17.92	. . 30
32, . .	"	.93	"	2.67	99.80	4.42	99.62	6.15	99.38	7.88	99.07	9.60	98 71	11.30	98.28	13.00	97.80	14.67	97.26	16.33	96.66	17.97	. . 32
34, . .	"	.99	"	2.73	"	4.48	"	6.21	99.37	7.94	99.06	9.65	98.69	11.36	98.27	13.05	97.78	14.73	97.24	16.39	96.64	18.03	. . 34
36, . .	"	1.05	99.92	2.79	99.79	4.53	99.61	6 27	99.36	7.99	99.05	9.71	98.68	11.42	98.25	13.11	97.76	14.79	97 22	16.44	96.62	18.08	. 36
38, . .	"	1.11	"	2.85	"	4.59	99.60	6.33	99.35	8.05	99.04	9.77	98.67	11.47	98.24	13.17	97.75	14.84	97.20	16.50	96.60	18.14	. . 38
40, . .	"	1.16	"	2.91	99.78	4.65	99.59	6.38	99.34	8.11	99.03	9.83	98.65	11.53	98.22	13.22	97.73	14.90	97.18	16.55	96.57	18.19	. 40
42, . .	"	1.22	99.91	2.97	"	4.71	"	6.44	99.33	8.17	99.01	9.88	98.64	11.59	98.20	13.28	97.71	14.95	97.16	16.61	96.55	18.24	. 42
44, . . .	99.98	1.28	"	3.02	99.77	4.76	99.58	6.50	99.32	8.22	99.00	9.94	98.63	11.64	98.19	13.33	97.69	15.01	97.14	16.66	96.53	18.30	. . 44
46, . .	"	1.34	99.90	3.08	"	4.82	99.57	6.56	99.31	8.28	98.99	10.00	98.61	11.70	98.17	13.39	97.68	15.06	97.12	16.72	96.51	18.35	. 46
48, . .	"	1.40	"	3.14	99.76	4.88	99.56	6.61	99.30	8.34	98.98	10.05	98.60	11.76	98.16	13.45	97.66	15.12	97.10	16.77	96.49	18.41	. . 48
50, . .	"	1.45	"	3.20	"	4.94	"	6.67	99.29	8.40	98 97	10.11	98.58	11.81	98.14	13.50	97.64	15.17	97.08	16.83	96.47	18.46	. . 50
52, . .	"	1.51	99.89	3.26	99.75	4.99	99.55	6.73	99.28	8.45	98.96	10.17	98.57	11.87	98.13	13.56	97.62	15.23	97.06	16.88	96.45	18.51	. . 52
54, . .	"	1.57	"	3.31	99.74	5.05	99.54	6.78	99.27	8.51	98.94	10.22	98.56	11.93	98.11	13 61	97.61	15.28	97.04	16.94	96.42	18.57	. . 54
56,	99.97	1.63	"	3.37	"	5.11	99.53	6.84	99.26	8.57	98.93	10.28	98.54	11.98	98.10	13 67	97.59	15.34	97.02	16.99	96.40	18.62	. 56
58,	"	1.69	99.88	3.43	99.73	5.17	99.52	6 90	99.25	8.63	98.92	10.34	98.53	12.04	98.08	13.73	97.57	15.40	97.00	17.05	96 38	18.68	. . 58
60,	"	1.74	"	3.49	"	5.23	99.51	6.96	99.24	8.68	98.91	10.40	98.51	12.10	98.06	13.78	97.55	15.45	96.98	17.10	96.36	18.73	. . 60
c— .75,	.75	.01	.75	.02	.75	.03	.75	.05	.75	.06	.75	.07	.75	.08	.74	.10	.74	.11	.74	.12	.74	.14	c— .75
c —1.00,	1.00	.01	1.00	.03	1.00	.04	1.00	.06	1.00	.08	.99	.09	.99	.11	.99	.13	.99	.15	.99	.16	.98	.18	c —1.00
c—1.25,	1.25	.02	1.25	.03	1.25	.05	1.25	.08	1.25	.10	1.24	.11	1.24	.14	1.24	.16	1.23	.18	1.23	.21	1.23	.23	c—1.25

M.	11°		12°		13°		14°		15°		16°		17°		18°		19°		20°		M.
	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	
0,′ . . .	96.36	18.73	95.68	20.34	94.94	21.92	94.15	23.47	93.30	25.00	92.40	26.50	91.45	27.96	90.45	29.39	89.40	30.78	88.30	32.14	. . 0′
2, ...	96.34	18.78	95.65	20.39	94.91	21.97	94.12	23.52	93.27	25.05	92.37	26.55	91.42	28.01	90.42	29.44	89.36	30.83	88 26	32.18	. . 2
4, ...	96.32	18.84	95.63	20.44	94.89	22.02	94 09	23.58	93.24	25.10	92.34	26.59	91.39	28.06	90 38	29.48	89.33	30 87	88.23	32.23	. . 4
6, ...	96.29	18.89	95.61	20.50	94.86	22.08	94.07	23.63	93.21	25.15	92.31	26.64	91.35	28.10	90.35	29.53	89.29	30.92	88 19	32.27	. . 6
8, ...	96.27	18.95	95.58	20.55	94.84	22.13	94.04	23.68	93.18	25.20	92.28	26.69	91.32	28.15	90.31	29.58	89 26	30.97	88.15	32.32	. . 8
10, ...	96.25	19.00	95.56	20.60	94.81	22.18	94.01	23.73	93.16	25.25	92.25	26.74	91.29	28.20	90.28	29.62	89.22	31.01	88.11	32.36	. . 10
12, ...	96.23	19.05	95.53	20.66	94.79	22.23	93.98	23.78	93.13	25.30	92.22	26.79	91.26	28 25	90.24	29.67	89.18	31.06	88.08	32.41	. . 12
14, ...	96.21	19.11	95.51	20.71	94.76	22.28	93.95	23.83	93.10	25.35	92.19	26.84	91 22	28.30	90.21	29.72	89.15	31.10	88.04	32.45	. . 14
16, ...	96.18	19.16	95 49	20.76	94.73	22.34	93.93	23.88	93.07	25.40	92.15	26.89	91.19	28.34	90.18	29 76	89.11	31.15	88.00	32.49	. . . 16
18, ...	96.16	19.21	95.46	20.81	94.71	22.39	93.90	23.93	93.04	25.45	92.12	26.94	91.16	28.39	90.14	29.81	89.08	31.19	87.96	32.54	. . 18
20, ...	96.14	19.27	95.44	20.87	94.68	22.44	93.87	23.99	93.01	25.50	92.09	26.99	91.12	28.44	90.11	29.86	89.04	31 24	87.93	32.58	. . . 20
22, ...	96.12	19.32	95 41	20.92	94.66	22.49	93 84	24.04	92.98	25.55	92.06	27.04	91.09	28.49	90.07	29.90	89.00	31.28	87.89	32.63	. . 22
24, ...	96.09	19.38	95.39	20.97	94.63	22.54	93 81	24.09	92.95	25.60	92.03	27.09	91.06	28.54	90.04	29.95	88.96	31.33	87 85	32.67	. . 24
26, ...	96.07	19.43	95.36	21.03	94.60	22.60	93.79	24.14	92.92	25.65	92.00	27.13	91.02	28.58	90 00	30.00	88.93	31.38	87.81	32.72	. . . 26
28, ...	95.05	19.48	95.34	21.08	94.58	22.65	93.76	24.19	92.89	25.70	91.97	27.18	90.99	28.63	89.97	30.04	88.89	31.42	87.77	32.76	. . 28
30, ...	96.03	19.54	95.32	21.13	94.55	22.70	93.73	24.24	92.86	25.75	91.93	27.23	90.96	28.68	89.93	30.09	88.86	31.47	87.74	32 80	. . 30
32, ...	96.00	19.59	95.29	21.18	94.52	22.75	93.70	24.29	92.83	25.80	91.90	27.28	90.92	28.73	89.90	30.14	88.82	31.51	87.70	32.85	. . . 32
34, ...	95.98	19.64	95.27	21.24	94.50	22.80	93.67	24.34	92.80	25.85	91.87	27.33	90.89	28.77	89.86	30.19	88.78	31.56	87.66	32 89	. . 34
36, ...	95.96	19.70	95.24	21.29	94.47	22.85	93.65	24.39	92.77	25.90	91.84	27.38	90.86	28.82	89.83	30.23	88 75	31.60	87.62	32.93	. . 36
38, ...	95.93	19.75	95.22	21.34	94 44	22.91	93.62	24 44	92.74	25.95	91.81	27.43	90.82	28.87	89.79	30.28	88.71	31.65	87.58	32.98	. . 38
40, ...	95.91	19.80	95.19	21.39	94.42	22.96	93.59	24.49	92.71	26.00	91.77	27.48	90.79	28.92	89.76	30.32	88.67	31.69	87.54	33.02	. . 40
42, ...	95.89	19.86	95.17	21.45	94.39	23 01	93.56	24 55	92.68	26.05	91.74	27.52	90.76	28.96	89.72	30.37	88.64	31.74	87.51	33 07	. . . 42
44, ...	95.86	19.91	95.14	21.50	94.36	23.06	93.53	24 60	92.65	26.10	91.71	27.57	90.72	29.01	89.69	30.41	88.60	31.78	87.47	33.11	. . . 44
46, ...	95.84	19.96	95.12	21.55	94.34	23.11	93.50	24.65	92.62	26.15	91.68	27.62	90 69	29.06	89.65	30.46	88.56	31.83	87.43	33.15	. . 46
48, ...	95.82	20.02	95.09	21.60	94.31	23.16	93.47	24 70	92.59	26.20	91.65	27.67	90 66	29.11	89 61	30.51	88 53	31 87	87.39	33 20	. . . 48
50, ...	95.79	20.07	95.07	21.66	94.28	23.22	93.45	24.75	92.56	26.25	91.61	27.72	90.62	29.15	89.58	30.55	88.49	31.92	87.35	32 24	. . . 50
52, ...	95.77	20.12	95.04	21.71	94.26	23.27	93.42	24.80	92 53	26 30	91.58	27.77	90.59	29.20	89.54	30.60	88.45	31.96	87.31	33.28	. . 52
54, ...	95 75	20.18	95 02	21.76	94.23	23.32	93.39	24.85	92.49	26.35	91.55	27.81	90.55	29.25	89.51	30.65	88.41	32.01	87.27	33 33	. . 54
56, ...	95.72	20.23	94.99	21.81	94 20	23.37	93.36	24.90	92.46	26.40	91.52	27.86	90.52	29.30	89.47	30.69	88.38	32.05	87.24	33 37	. . 56
58, ...	95.70	20.28	94.97	21.87	94.17	23.42	93.33	24.95	92 43	26.45	91.43	27 91	90.48	29.34	89.44	30.74	88 34	32 09	87 20	33.41	. . 58
60, ...	95.68	20.34	94.94	21.92	94.15	23.47	93.30	25.00	92.40	26.50	91.45	27.96	90.45	29.39	89.40	30.78	88.30	32.14	87.16	33.46	. . . 60
c— .75,	.73	.15	.73	.16	.73	.17	.73	.19	.72	.20	.72	.21	.72	.23	.71	.24	.71	.25	.70	.26	c— .75
c —1.00, .	.98	.20	.98	.22	.97	.23	.97	.25	.96	.27	.96	.28	.95	.30	.95	.32	.94	.33	.94	.35	c—1.00
c—1.25, .	1.22	.25	1.22	.27	1.21	.29	1.21	.31	1.20	.34	1.20	.35	1.19	.38	1.19	.40	1.18	.42	1.17	.44	c—1.25

M.	21°		22°		23°		24°		25°		26°		27°		28°		29°		30°		M.
	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	
0′, . . .	87.16	33.46	85.97	34.73	84.73	35.97	83.46	37.16	82.14	38.30	80.78	39.40	79.39	40.45	77.96	41.45	76.50	42.40	75.00	43 30	. . 0′
2, ...	87.12	33.50	85.93	34 77	84.69	36.01	83.41	37.20	82.09	38.34	80.74	39.44	79.34	40.49	77.91	41.48	76.45	42.43	74.95	43.33	. . . 2
4, ...	87.08	33.54	85.89	34.82	84.65	36.05	83.37	37.23	82.05	38.38	80 69	39.47	79.30	40.52	77.86	41.52	76.40	42.46	74 90	43.36	. . . 4
6, ...	87.04	33.59	85.85	34 86	84.61	36.09	83.33	37.27	82.01	38.41	80.65	39.51	79.25	40.55	77 81	41.55	76.35	42.49	74.85	43 39	. . 6
8, ...	87.00	33 63	85.80	34.90	84.57	36.13	83.28	37.31	81 96	38.45	80.60	39.54	79 20	40.59	77.77	41.58	76.30	42 53	74.80	43.42	. . 8
10, ...	86.96	33.67	85.76	34.94	84.52	36.17	83.24	37.35	81.92	38.49	80.55	39.58	79.15	40.62	77.72	41.61	76.25	42.56	74.75	43.45	. . . 10
12, ...	86.92	33.72	85.72	34.98	84.48	36.21	83.20	37.39	81.87	38.53	80.51	39.61	79.11	40.66	77.67	41.65	76.20	42.59	74.70	43.47	. . . 12
14, ...	86.88	33.76	85.68	35.02	84.44	36.25	83 15	37.43	81.83	38.56	80.46	39.65	79.06	40.69	77 62	41.68	76 15	42.62	74.65	43.50	. . . 14
16, ...	86.84	33.80	85.64	35.07	84.40	36.29	83.11	37.47	81.78	38.60	80 41	39.69	79.01	40.72	77.57	41.71	76.10	42.65	74.60	43.53	. . . 16
18, ...	86.80	33 84	85.60	35.11	84.35	36.33	83.07	37.51	81.74	38.64	80.37	39.72	78.96	40.76	77.52	41.74	76.05	42 68	74.55	43.56	. . . 18
20, ...	86.77	33.89	85.56	35.15	84.31	36.37	83.02	37 54	81.69	38.67	80.32	39.76	78.92	40.79	77.48	41.77	76.00	42.71	74.49	43.59	. . 20
22, ...	86.73	33.93	85.52	35.19	84.27	36.41	82.98	37.58	81.65	38.71	80.28	39.79	78.87	40.82	77.42	41.81	75.95	42.74	74.44	43.62	. . 22
24, ...	86.69	33.97	85.48	35.23	84.23	36.45	82.93	37.62	81.60	38.75	80.23	39.83	78 82	40.86	77.38	41.84	75.90	42.77	74.39	43.65	. . 24
26, ...	86.65	34.01	85.44	35.27	84.18	36.49	82.89	37.66	81.56	38.78	80.18	39.86	78.77	40.89	77.33	41.87	75.85	42.80	74.34	43.67	. . . 26
28, ...	86.61	34.06	85.40	35.31	84.14	36.53	82.85	37.70	81.51	38.82	80.14	39.90	78.73	40.92	77.28	41.90	75.80	42.83	74.29	43.70	. . 28
30, ...	86.57	34.10	85.36	35.36	84.10	36.57	82.80	37.74	81.47	38.86	80.09	39.93	78.68	40.96	77.23	41.93	75.75	42.86	74.24	43.73	. . 30
32, ...	86.53	34.14	85.31	35.40	84.06	36.61	82.76	37.77	81.42	38.89	80.04	39.97	78.63	40.99	77.18	41.97	75.70	42.89	74.19	43.76	. . . 32
34, ...	86.49	34.18	85.27	35.44	84.01	36.65	82.72	37.81	81.38	38.93	80.00	40.00	78.58	41 02	77.13	42.00	75.65	42.92	74.14	43.79	. . . 34
36, ...	86.45	34.23	85.23	35.48	83 97	36.69	82.67	37.85	81.33	38.97	79.95	40.04	78.54	41.06	77.09	42.03	75.60	42.95	74.09	43.82	. . . 36
38, ...	86.41	34.27	85.19	35.52	83.93	36.73	82.63	37.89	81.28	39.00	79.90	40.07	78 49	41.09	77.04	42.06	75.55	42.98	74.04	43.84	. . . 38
40, ...	86.37	34.31	85.15	35.56	83.89	36.77	82.58	37.93	81.24	39.04	79.86	40.11	78.44	41.12	76.99	42.09	75.50	43.01	73.99	43.87	. . . 40
42, ...	86.33	34.35	85.11	35.60	83.84	36.80	82.54	37.96	81.19	39.08	79.81	40.14	78.39	41.16	76.94	42.12	75.45	43.04	73.93	43.90	. . . 42
44, ...	86.29	34.40	85.07	35.64	83.80	36.84	82.49	38.00	81.15	39.11	79.76	40.18	78.34	41.19	76.89	42.15	75.40	43.07	73.88	43.93	. . . 44
46, ...	86.25	34.44	85.02	35.68	83.76	36.88	82.45	38.04	81.10	39.15	79.72	40.21	78.30	41.22	76.84	42.19	75.35	43.10	73.83	43.95	. . . 46
48, ...	86.21	34.48	84.98	35.72	83.72	36.92	82.41	38.08	81.06	39.13	79.67	40.24	78.25	41.26	76.79	42.22	75.30	43.13	73.78	43.98	. . . 48
50, ...	86.17	34.52	84.94	35.76	83.67	36.96	82.36	38.11	81.01	39.22	79.62	40.28	78.20	41.29	76.74	42.25	75.25	43.16	73.73	44.01	. . 50
52, ...	86.13	34.57	84.90	35.80	83.63	37.00	82.32	38.15	80.97	39.26	79.58	40.31	78.15	41 32	76.69	42.28	75.20	43.18	73.68	44.04	. . 52
54, ...	86.09	34.61	84.86	35.85	83.59	37.04	82.27	38.19	80.92	39.29	79.53	40.35	78.10	41 35	76.64	42.31	75.15	43.21	73.63	44.07	. . . 54
56, ...	86.05	34.65	84.82	35.89	83.54	37.08	82.23	38.23	80.87	39.33	79.48	40.38	78.06	41.39	76.59	42.34	75.10	43.24	73.58	44.09	. . . 56
58, ...	86.01	34.69	84.77	35.93	83.50	37.12	82.18	38.26	80.83	39.36	79.44	40.42	78.01	41.42	76.55	42.37	75.05	43.27	73.52	44.12	. . . 58
60, ...	85.97	34.73	84.73	35.97	83.46	37.16	82.14	38.30	80.78	39.40	79.39	40.45	77.96	41.45	76.50	42.40	75.00	43.30	73.47	44.15	. . . 60
c— .75, .	.70	.27	.69	.29	.69	.30	.68	.31	.68	.32	.67	.33	.66	.35	.66	.36	.65	.37	.65	.38	c— .75
c—1.00, .	.93	.37	.92	.38	.92	.40	.91	.41	.90	.43	.89	.45	.89	.46	.88	.48	.87	.49	.86	.51	c—1.00
c—1.25, .	1.16	.46	1.15	.48	1.15	.50	1.14	.52	1.13	.54	1.12	.56	1.11	.58	1.10	.60	1.09	.62	1.08	.64	c—1.25